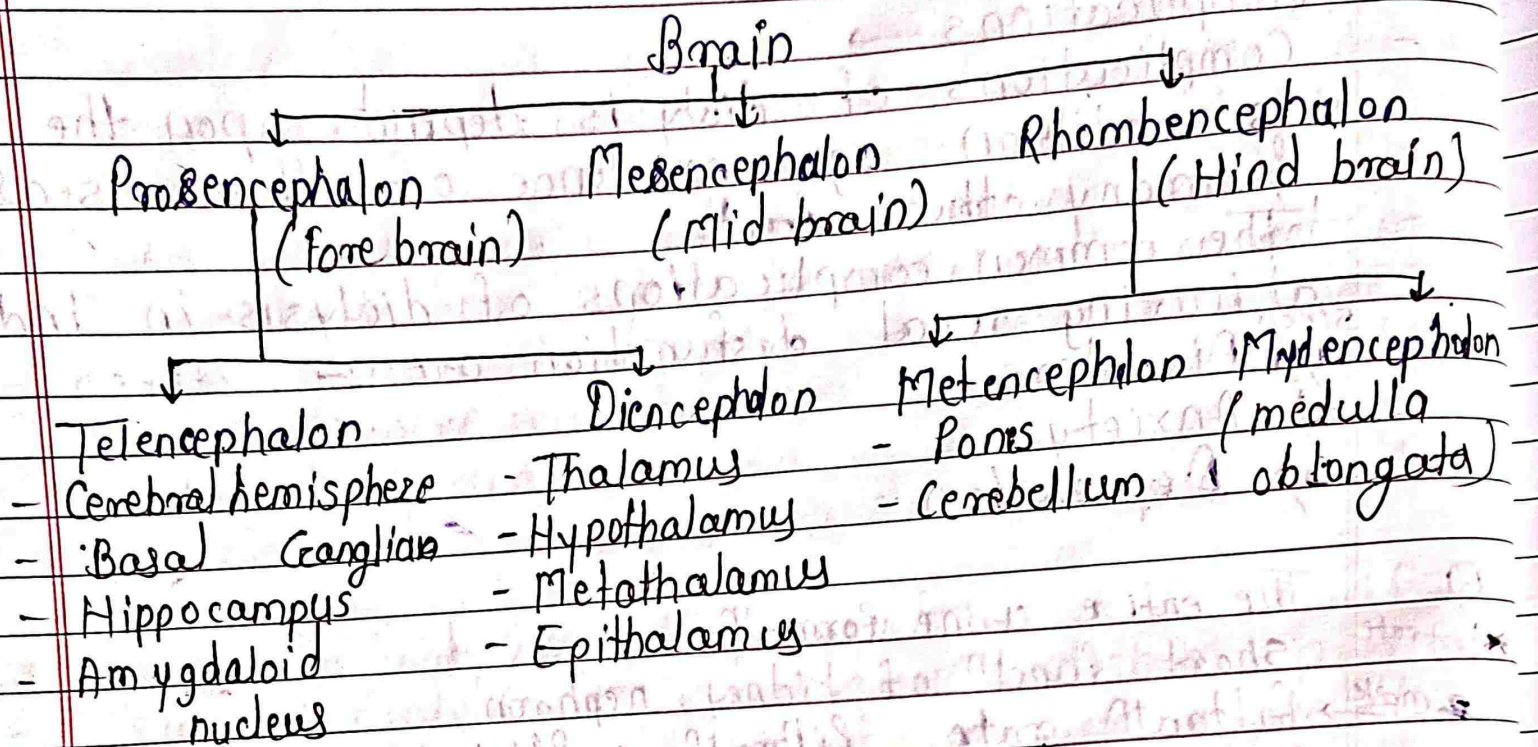
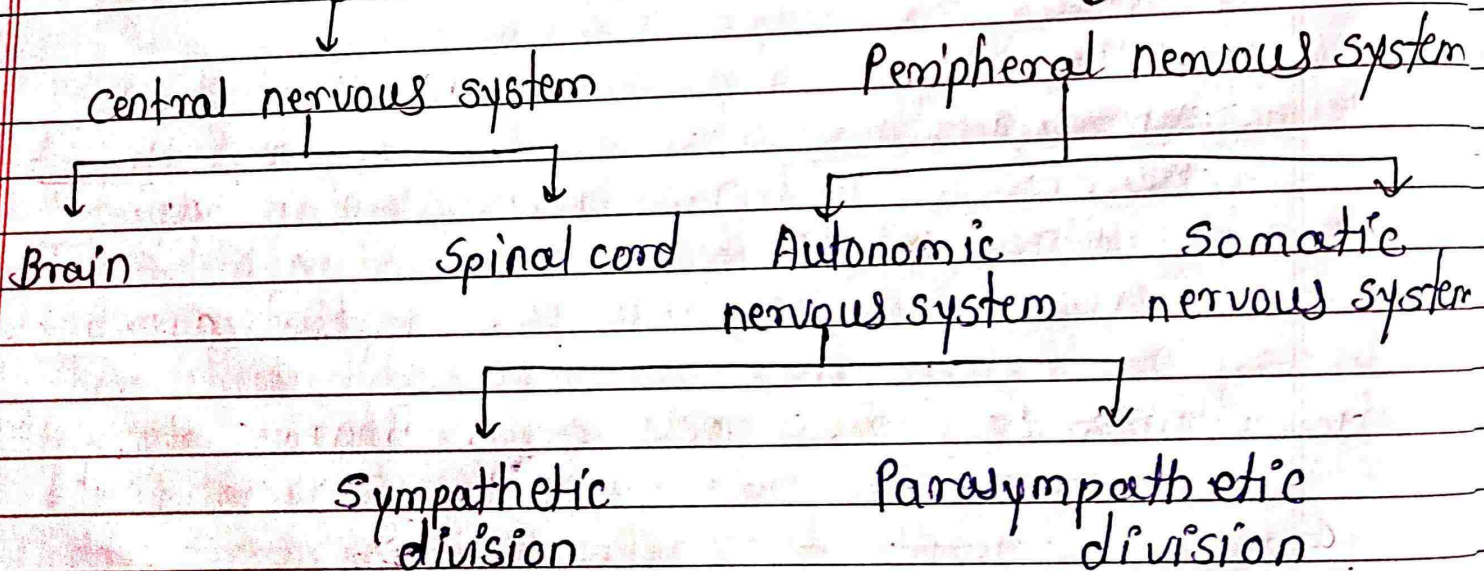


Nervous System



Nervous System



Introdⁿ to nervous system

neurons

mechanism of propagatⁿ of nerve impulse

physiology of CNS, PNS, ANS, sensory & motor nervous system

Functⁿ of diff part of brain intelligence, memory, learning, motivation

* Introduction →

- Nervous system is the control & communication system of body.
- Nervous system controls all our activities & time moments of the body & the other one being endocrine system.
- The nervous system is a complex network of nerves & cells that carry messages to & from the brain & spinal cord to various parts of the body.

• Divisions of Nervous system →

It is divided into 2 parts

- 1) Central Nervous system
- 2) Peripheral Nervous system

1) Central Nervous system

- Central nervous system includes brain & spinal cord

- It is formed by the neurons & supporting cells called neuroglia.

- They are arranged in two layers gray matter & white matter.

- Where in gray matter is formed by nerve cell bodies & the proximal parts of nerve fibres which are arising from nerve cell body.

- White matter is formed by remaining part of the nerve fibers.

- Brain is situated in skull & it is continued as a spinal cord in vertebral canal through foramen magnum.

- Brain & spinal cord are surrounded by three

layers of meninges called the outer dura matter, middle ^{arachnoid} arachnoid matter & the inner ^{pia} pia matter.

- And the space betⁿ arachnoid matter & pia matter is known as subarachnoid space & these space is filled ^{with} by a fluid called as cerebrospinal fluid.

Parts of Brain →

- Brain consists of three major divisions →

1) Prosencephalon is otherwise called as fore-brain.

- It is again divided in two

↓ Telencephalon

↓ Diencephalon

- Cerebral hemisphere

- Thalamus

- Basal Ganglia

- Hypothalamus

- Hippocampus

- Metathalamus

- Amygdaloid nucleus

- Epithalamus

2) Mesencephalon is called as mid brain.

3) Rhombencephalon is also called as hind brain.

It is subdivided into two parts.

↓ Metencephalon

↓ Myelencephalon

- Pons, Cerebellum

(Medulla oblongata)

2) Peripheral Nervous System

- It is formed by ^{the} neurons & their processes present in all parts of the body.

- It consists of neurons cranial nerves, arising from brain & spinal nerve, arising from the spinal cord.
- It is again divided into 2 sub divisions

Autonomic Nervous System

Somatic Nervous System

- SNS :- SNS is concerned with the somatic functions. It includes the nerves supplying the skeletal muscles. And are responsible for muscular activity & the movements of the body.

- ANS :- ANS is concerned with the regulation of the visceral functions or vegetative functions.

- They are involuntary nervous system.

ANS is consist of two divisions -

- 1) Sympathetic division
- 2) Parasympathetic division

• Neuron

- Nerve cells or neuron is defined as a functional unit of nervous system.
- This cells have the nucleus & all other organelles in the cytoplasm except - centrosome. So, it cannot undergo divisions.

- Classification of Neurons → They are 3

1) Depending upon the no of poles

- They are
- 1) unipolar
 - 2) Bipolar
 - 3) Multipolar

1) Unipolar Neurons

- Unipolar type of nerve has only one type of pole.

- from a single pole, both axon & dendrite arise.
- This type of neurons arise in embryonic stage.

2) Bipolar Neurons

- These neurons has 2 poles.
- Axon arises from 1 pole & dendrites arise from other pole.

3) Multipolar Neurons

- Multipolar neurons have many poles.
- One pole give rise to axon & all other poles give rise to dendrites.

1) Depending upon the function → They are classified into 2 types.

1) Motor or Efferent Neurons

2) Sensory or Afferent Neurons

1) Motor or Efferent Neurons

- Motor neurons carry the motor impulses from the central nervous system to the peripheral part of the body. Like muscles, glands, blood vessels, etc.
- Motor neurons have one ^{long} axon & short dendrites.

2) Sensory or Afferent Neurons

- Sensory neurons which carry sensory impulses from peripheral part to the central nervous system.
- Sensory neurons has a short axon & long dendrites.

3) Depending upon the length of the axon →

They are of 2 types :-

- 1) Golgi type I neurons
- 2) Golgi type II neurons

1) Golgi type I neurons

Have a very long axon & reaches to the remotest part of the peripheral organ.

Eg :-

2) Golgi type II neurons

These have short axon.

- These neuron are present in cerebral cortex and spinal cord.

* Structures of Neurons →

Neuron is made up of basically 3 parts :-

- 1) Nerve cell body
- 2) Dendrites
- 3) Axon

1) Nerve cell body

N.C.B is known as soma or perikaryon / nikaryon

- It is irregular in shape.

- It has a cytoplasm called as neuoplasm which is covered by cell membrane.

- The cytoplasm consist large nucleus, ~~nasal~~ nissl bodies, neurofibril, mitochondria & golgi apparatus.

- ~~Nasal~~ nissl bodies & neurofibrils are found only in nerve cells.

2) Dendrite

- Dendrite is a branched process of neurons. It is further branched repeatedly.
- Dendrite may be present or absent.
- Dendrite has ^{Nissl} granules & neurofibrils.
- Dendrite transmits the impulses towards the nerve cell body.
- Dendrites are shorter than axon.

3) Axon

- Axon are longer process of nerve cells.
- Each neuron has only one axon.
- It is devoid of ^{Nissl} granules.
- Axon extends ~~from~~ a long distance away from the nerve cell body.
- The length of axon is about 1m.

* Nerve Cell Body →

- Nucleus - Each neuron has only one nucleus & centrally placed has one or two prominent nucleoli. It does not have centrosome.
- Nissl Bodies - Nissl bodies are small ^{basophilic} ~~mesophic~~ granules found in cytoplasm of neurons. These bodies are present in soma & dendrites but not in axon.
- Neurofibrils - Neurofibrils are thread like str present in form of network in the soma & nerve process.
- Mitochondria - Mitochondria are present in

some of axon. As in other cells, here also mitochondria form the powerhouse of the nerve cell.

- Golgi apparatus - These are concerned with the processing & packaging of proteins.
- Myelin sheath - It is a thick glycoprotein sheath that insulates the myelinated nerve fibre.
 - It is not continuous & the area where myelin sheath is absent is called as node of Ranvier.
 - Segment betⁿ two nodes are called as internode.
 - & it is responsible for white colour.
- Functions →
 - 1) Faster conduction.
 - 2) Insulating capacity.

* Classification of Nerve fibre

Nerve fibres are classified by 6 different methods :-

- 1) Depending upon the structure :- It is classified in 2 types
 - 1) Myelinated nerve fibres
 - 2) Non-myelinated nerve fibres
- 1) MNF are the nerve fibres which are covered by myelin sheath.
- 2) N-MNF are nerve fibres which are not covered by myelin sheath.
- 2) Depending upon the distribution -
It is classified into 2 types →
 - 1) Somatic nerve fibres :-

Somatic nerve fibers supply the skeletal muscles of the body.

2) Autonomic nerve fibers → supplied the various internal organs of the body.

3) Depending upon the origin →

It is divided into 2 types.

1) Cranial nerve fibers —

These nerve fibers arise from brain.

2) Spinal nerve fibers —

Nerve fibers arising from the spinal cord are called spinal nerve fibers.

4) Depending upon the functions →

It is classified into 2 types :-

1) Sensory nerve fibers —

SNF carry sensory impulses from different parts of the body to the central nervous system.

2) Motor nerve fibers —

MNF carry motor impulses from central nervous system to the different parts of the body.

5) Depending upon the secretion of Neurotransmitter —
It is classified into 2 types —

1) Adrenergic Nerve fibers

2) Cholinergic Nerve fibers

6) Depending upon the diameter & conduction of impulse $\rightarrow$

Type	Diameter (μ)	Velocity of conduct ⁿ (m/sec)
A alpha	12 to 24	70 to 120
A beta	6 to 12	30 to 70
A gamma	5 to 6	15 to 30
A delta	2 to 5	12 to 15
B	1 to 2	3 to 10
C	< 1.5 (less than 1.5)	0.5 to 2

* Velocity of impulse —
V of I is directly proportional to the thickness of nerve fiber.

• Properties of Nerve fiber :-

1) Excitability :- Is defined as a physiochemical change is occur in tissue when stimulation is applied.

• Stimulatⁿ is defined as a external agent which produces excitability in the tissues.

Response due to stimulatⁿ $\rightarrow$

Based on the strength of stimulatⁿ 2 types of response develop.

1) Action potential

2) Electronic potential

1) Action potential

Actⁿ potential develops when the nerve fibers is stimulated by a stimulatⁿ with 'adequate' strength.

* The strength should be more than that of the threshold strength.

• Actⁿ potential is propagated

2) Electrotonic potential →
When the stimulus is with subliminal strength only electrotonic potential is developed. Electrotonic potential is non-propagated.

* Difference betⁿ electrical potential in nerve fiber & muscle fiber →

Events	Nerve fibers	Skeletal Muscle fibers
Resting membrane potential	-70 mv	-90 mv
Firing level	-55 mv	-75 mv
End of depolarisation	+35 mv	+55 mv

Excitability of
nerve fibre is
4 times
skeletal fibres

• Electrotonic Potential or Local Potential →

- A subliminal or subthreshold stimulus does not produce an action potential but it alters the resting ^{membrane} potential & produce slight depolarization for about 7 mv.
- This slight depolarisation state is called electrotonic potential.
- Firing level is reach only if depolarisation occur upto 15 mv/volts. Then only action potential can develop.

• Properties of Electrotonic Potential

- Electrotonic potential is non-propagated.
- If the intensity or the stimulus is increase gradually every time there is increase in the amplitude till the firing level is reach that is 15 mv/volts.

Note :- Depolarisation → Is a change within the cell during which cell undergoes a shift in electric

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Note :- Depolarization → Is a change within the cell during which cell undergoes a shift in electric

charge distributⁿ resulting in less -ve. charge inside the cell.

• Cell membrane potential →

Cell maintains an internal environment that is -vely charge relative to the external environment of the cell, this difference in charge is called as cell membrane potential.

- In the process of depolarisatⁿ the -ve internal charge of the cell becomes more +ve temporarily. This change occur during action potential.

* Conductivity →

Conductivity is the ability of nerve fibers to transmit the impulse from the area of stimulation to the other areas.

- Actⁿ potential is transmitted through the nerve fibers as a nerve impulse.

• Mechanism →

Depolarisation occurs 1st at the sight of stimulatiⁿ in the nerve fiber.

- Then it causes depolarisation of the neighbouring area & this depolarisation travels throughout the nerve fiber.

- Depolarisatⁿ is followed by repolarisation.

* Conductⁿ through myelinated nerve fiber: Saltatory Conduction →

- Saltatory conductⁿ is a form of conductⁿ of nerve impulses in which the impulses jump from one node to another.

- The conductⁿ of impulse through a myelinated

nerve fiber is about 50 times faster than through a non-myelinated nerve fibre.

* Refractory Period →

- Refractory period is a period at which the nerve does not give any response for the stimulus.

- Types of refractory period → It is of 2 types

1) Absolute Refractory Period

ARP is the period during which the nerve does not show any response at all, whatever may be the strength of stimulus.

2) Relative Refractory Period

It is a period during which nerve fibres shows response if the strength of stimulus is increase to the maximum.

* Summation →

- If two or more subliminal stimulus are applied within a short interval of about 0.5 m/sec the response is produced.

- It is because the subliminal stimuli are summed up together to become strong enough to produce the response. This phenomenon is called as summation.

* Adaptation →

- While stimulating the nerve fibers continuously the excitability of the nerve fiber is greater in the beginning. Later the response

decreases slowly & finally the nerve fiber does not show any response at all.

This phenomenon is known as adaptation or accommodation.

Infatigability →

Nerve fibers cannot be fatigued even if it is stimulated continuously for a long time. Because nerve fibers can conduct only one action potential at a time. At that time it is completely refractory & does not conduct another action potential.

Physiology of Sensory Nervous System →

Somatosensory system ⇒

Somatosensory system is defined as sensory system associated with diff. parts of the body.

It is also defined as faculty of bodily perception of various sensation.

Sensation are of 2 types —

- 1) Somatic sensation
- 2) Special sensation.

1) **Somatic sensation** →

Somatic sensation are arising from skin, muscle, tendon & joint.

These sensatⁿ have specific receptor.

2) **Special sensation** →

Special sensation are complex sensatⁿ for which body has some specialised sense organ.

The special sensatⁿ are vision, hearing, taste & smell.

• Types of Somatic Sensation →
Somatic sensatⁿ are classified into 3 types.

A) Epithetic sensation

B) Protopathic sensation

C) deep sensation

A) Epithetic Sensation -

Epithetic sensatⁿ are minute or light sensatⁿ such sensatⁿ are perceived more accurately.

Epithetic sensation are further classified into

i) Fine touch or tactile sensation →

These are mildest of sensatⁿ one can perceive

ii) Tactile localization →

Ability to identify the exact point of body where stimulation is done without looking at the site.

iii) Tactile discrimination →

The ability to differentiate the type of sensation through touch.

iv) Temperature sensation →

Ability to differentiate the temp ranging betⁿ 25°C to 40°C.

B) Protopathic or crude sensation →

These are crude sensatⁿ with the stronger stimulatⁿ than the epithetic type of sensatⁿ.

Protopathic sensatⁿ are of 3 types -

1) Pressure sensation

2) Pain sensation

3) Temp sensation

I) Pressure Sensation →

These are type of sensatⁿ generated the pressure is exerted on particular site.

II) Pain Sensation →

Type of sensatⁿ produced when the stimulatⁿ stronger than the threshold value activating the pain receptor.

III) Temperature Sensation with wider range.

c) Deep Sensation →

Are sensatⁿ arising from deeper structures below the skin & visceral organs.

i) Pallesthesia or sensatⁿ of vibration

ii) Kinesesthesia

iii) Visceral pain sensatⁿ

i) Pallesthesia / sensatⁿ of vibration →

Which is combination of touch & pressure sensatⁿ.

ii) Kinesesthesia / kinesthetic sensation →

sensatⁿ of position & movement of diff. parts of body.

These sensatⁿ arising from proprioceptor present in muscle, tendon, joints & ligaments.

iii) Visceral pain sensation → Arising from viscera.

* Sensory pathway →

Nervous pathway of sensation are called sensory pathway. These pathway carry the impulses from receptor in different parts of body to centre in brain.

- Sensory pathway are of 2 types:

- 1) Pathways of somatic sensory system.
- 2) Pathways of visceral sensory system.

1) Pathways of somatic sensory system

Conveys the informatⁿ from sensory receptors in skin, skeletal muscles & joints.

Pathways of these system are constituted by somatic nerve fibers called as somatic afferent nerve fibers.

2) Pathways of visceral sensory system

P of VS conveys the informatⁿ from receptors of the viscera.

Pathway of these system are constituted by autonomic nerve fibers.

~~Ex~~ Sensory fibers of trigeminal nerve

- TN carries somatosensory informatⁿ from face, teeth, periodontal tissues, oral cavity, nasal cavity, cranial dura matter & scalp & extrinsic muscle of eyeball.

• ^{Sensory nerve} Origin :- ~~S~~ fibers of trigeminal nerves arise from trigeminal ganglion situated near the temporal bone.

The peripheral process of the neurons from these ganglion forms three divisions of trigeminal nerve.

1) Ophthalmic division -> OD enters the orbital cavity through orbital fissure.

are receptor is known as proprioceptors

classmate

Date _____
Page _____

2) Maxillary division → These divisions comes out of the cranial cavity through the foramen rotundum.

3) Mandibular division → Exist cranial cavity through foraminal oval.

Central Part -
• Sensory roots from trigeminal ganglion extends into the brain stem & joints in 3 Nucleus.

- 1) Mesencephalic Nucleus
- 2) Principle sensory condin nucleus.
- 3) Spinal nucleus of trigeminal nerve

Receptors

Receptors are the sensory nerve ending that terminate in the peniphery as bare unmyelinated endings or in the form of specialised capsulated structure.

Receptors produce a series of impulses which are transmitted through afferent nerve.

Receptors are biological transducers which converts various form of energy in the environment into action potential.

• Classification of Receptors →

It is classified into 2 types -

1) Exteroceptors

2) Interoceptors

1) Exteroceptor → It is of 3 types →

are receptors which give response to stimuli for arising from outside to the body.

1) Cutaneous Receptors or Mechanoreceptors →

The receptors situated in the skin are called

the cutaneous receptors — mechanical

- They give response to the stimuli like touch, pressure & pain

2) Chemoreceptors —

- The receptors which give response to chemical stimuli are called the chemoreceptors.

3) Teleoreceptors —

- Teleoreceptors are the receptors that give response to stimuli arising away from the body.
- These receptors are called the distance receptors.

2) Interoceptors →

- are the receptors which give response to stimuli arising from within the body.

They are of 2 types —

1) Visceroceptors

- The receptors which are present within the viscera are called visceroceptors.

2) Proprioceptors

- receptors which gives response to change in the position of different parts of the body.

Properties of Receptors →

1. # Specificity of response — It is a response given by particular type of receptors to a specific sensation.

Eg: — Temperature receptors give response ^{only} to temp. sensation.

2. # Sensory adaptation — Is the decline in discharge of sensory impulses when a receptors is

stimulated continuously with constant strength.
Depending on this receptors are classified into 2 types —

1) ~~Ha~~ Phasic Receptors

They get adapted rapidly.

Eg:- Touch & pressure receptors.

2) Tonic Receptors

Which get adapted slowly.

Eg:- Pain receptors and cold receptors.

3. # Response to increasing the strength of stimulus →

During the stimulation of receptors if the response given by receptors is to be double the strength of stimuli increase by 100 times.

4. # Sensory Transduction - ST in a receptors is a process by which the energy in the environment is converted into electrical impulse.

5. # Receptor Potential →

RP is a non-propagated transmembrane potential difference that develops when a receptors is stimulated.

* Synapse →

Synapse is junctⁿ betⁿ 2 neurons.
It is only physiological continuity betⁿ 2 neuron cell.

Synapse is classified be into 2 method —

1) Anatomical classification

2) Functional classification

1) Anatomical classification -

Depending of ending of axon synapse is classified into 3 types :-

i) Axo-axonic synapse - It is type of synapse in which axon of one neuron terminates ^{on} axon of ^{other} neuron.

ii) Axo-dendritic synapse - In which axon of one neuron terminates ^{on} dendrites of another neuron.

iii) Axo-somatic synapse -

In which axon of one neuron ends on soma of another neuron.

2) Functional classification -

Based on the mode of impulse transmission

i) electrical synapse

ii) chemical synapse

Electrical Synapse - This is a type of synapse in which the physiological ^{continuity} activity betⁿ the presynaptic neurons is provided by gap junction betⁿ the 2 neurons. There is a direct exchange of ions betⁿ the two neurons ^{through} for this gap junction.

- In electrical synapse the synaptic delay is very less because of direct flow of current.
- Electrical synapse is seen in cardiac muscle fibre, smooth muscle fibres of intestine & the epithelial cells of lens in the eye.

Chemical Synapse - The chemical synapse is the junctⁿ betⁿ two nerve fibers through which the signals are transmitted by release of chemical transmitter.

- In chemical synapse there is no continuity betⁿ two neurons because of presence of space called as synaptic cleft betⁿ two neurons.
- The actⁿ potential reaching the pre-synaptic terminal causes the release of neuro-transmitter substance from the vesicles of the ^{axon} terminale.
- The neurotransmitter reaches the post-synaptic neuron through synaptic cleft & causes the productⁿ of potential of change.

* **Functions of Synapse** →

Depending on functⁿ of synapse they are of two types -

- 1) **Excitatory synapses** (which transmit the impulse)
- 2) **Inhibitory synapses** (which inhibit the transmission of impulses)

1) Excitatory function

Excitatory post synaptic potential

How excitatory post synaptic potential developed.

1) EPSP is a non-propagated electrical potential that develops during the process of synaptic transmission.

• Arrival actⁿ potential in axon terminal

↓
① Causes opening of calcium channels

Pre-synaptic
neuron

↓
Influx of calcium ions from extracellular fluid.

↓
Opening of vesicles & release of ACh (Acetylcholine)

↓
Passage of ACh through synaptic cleft

↓
formation of ACh / receptor complex

Post synaptic
neuron

↓
Opening of sodium channels & influx of sodium ions from extracellular fluid.

↓
Development of EPSP

↓
Opening of Na channels in initial segment of axon

↓
Influx of sodium ions from

extracellular fluid & development
of actⁿ potential

↓
Spread of actⁿ potential through
axon of post synaptic neuron.

2) Inhibitory function.

- It can be classified into 3 types -

- 1) Post-synaptic inhibition
- 2) Pre-synaptic inhibition
- 3) Renshaw cell inhibition or Negative Feedback

1) Post-synaptic inhibition →

This occurs due to release of an inhibitory neurotransmitter from pre-synaptic terminal instead of excitatory neuro-transmitter sub. It is also called as direct inhibition.

Ex: gamma amino butyric acid, dopamine, glycine

2) Pre-synaptic inhibition →

It is the synaptic inhibiⁿ which occurs bcz of failure of pre-synaptic axon terminal to release the excitatory neurotransmitter substance.

- It is also called as indirect inhibition.

3) Renshaw cell inhibiⁿ →

It is type of synaptic inhibiⁿ which is caused by Renshaw cells in spinal cord.

- Renshaw cells are small motor neurons

present in anterior gray-horn of spinal cord.

- When the motor neurons send a motor impulses reach the Renshaw cell.

Then these cells are stimulated which sense inhibitory impulses to alpha motor neuron so that the discharge from motor neuron is reduced.

* Properties of Synapse →

- 1) One-way conductⁿ - The impulses are transmitted only in one direction in synapse.
- 2) Synaptic delay - is short delay occurring during the transmission of impulses through the synapse.
- 3) Fatigue - The fatigue at the synapse due to depletion of neurotransmitter such as acetylcholine.
- 4) Summation - It is the fusion of effects or the progressive increase in the excitatory postsynaptic potential.

Neurotransmitters →

Neurotransmitters is a chemical substance that act as a mediator for the transmission of nerve impulses from one neuron to another neuron through a synapse.

• Criteria for Neurotransmitter →

- 1) Substance must be found in a neuron.
- 2) It must be produced by neuron.
- 3) It must be released by neuron.
- 4) It must act on target ^{organ} & produce some biological effect.
- 5) After action it must be inactivated.

Classification of Neurotransmitter →

- Depending upon chemical Nature :-

It is classified into 3 types -

1) Amino acid - They are involved in fast synaptic transmission and are inhibitory and excitatory in action.

Eg: ① GABA - site of secretⁿ - cerebral cortex, cerebellum, basal ganglia, spinal cord, ~~trachea~~ retina.
Actⁿ - inhibitory

② Glycine - site of secretⁿ - forebrain, brain stem, spinal cord & retina.
Actⁿ - inhibitory

③ Glutamate - site of secretⁿ - cerebral cortex, brain stem & cerebellum.
Actⁿ - Excitatory

④ Aspartate - site of secretⁿ - cerebellum, spinal cord & retina.
Actⁿ - Excitatory

2) Amines

Amines are modified amino acid, this neurotransmitter involves in slow synaptic transmission.

They are also inhibitory and excitatory in action.

Ex: ① Nor adrenaline - site of secretⁿ - post ~~syno~~ ganglionic adrenergic sympathetic nerve endings, cerebral cortex, hypothalamus, basal ganglia, brain stem.

Actⁿ - Excitatory & Inhibitory

② Adrenaline - site of secretⁿ - hypothalamus, thalamus & spinal cord.

Actⁿ - Excitatory & Inhibitory

③ Dopamine - site of secretⁿ - basal ganglia, hypothalamus, lymphic system, neocortex, retina & sympathetic ganglia.

Actⁿ - Inhibitory

④ Serotonin - site of secretⁿ - hypothalamus, lymphic system, cerebellum, GI tract, lungs and platelets, spinal cord, retina.

Actⁿ - Inhibitory

⑤ Histamine - site of secretⁿ - hypothalamus, GI tract and mast cells, cerebral cortex.

Actⁿ - Excitatory

3) Others :-

① Acetylcholine

① Nitric oxide - site of secretⁿ - many parts of CNS, neuromuscular junction & GI tract.

Actⁿ - Excitatory

② Acetylcholine - site of secretⁿ - pre-ganglionic parasympathetic nerve endings, etc.

Actⁿ - Excitatory

• Depending Upon the function →

- Neurotransmitters are classified into 2 types —

i) Excitatory Neurotransmitters

ii) Inhibitory Neurotransmitters

i) Excitatory Neurotransmitter - EN is a chemical subst which is responsible for conduction of impulse from pre-synaptic ^{neuron} neuron to the post-synaptic neuron.

• Excitatory

ii) Inhibitory Neurotransmitter → IN is a chemical sub. which inhibits the conduction of impulse from pre-synaptic neuron to the post-synaptic neuron.

Inhibitory post synaptic Potential →
When neurotransmitter is released from pre-synaptic axon terminal due to arrival of action potential it causes the opening of potential channels in the post-synaptic membrane and influx of potassium ion. This is to hyper.

This is called as inhibitory post synaptic
- When IPSP is developed the action potential is not generated in post-synaptic neuron

Release of Neurotransmitter →

The neurotransmitter is produced in soma and is transported through axon.

At axon terminal the neurotransmitter is stored in small pockets called vesicles.

Under the influence of stimulus these vesicles are opened and neurotransmitter are released in synaptic cleft.

Inactivation of Neurotransmitter →

It gets inactivated by 4 methods —

i) It diffuses out of the synaptic cleft where the area it has no action.

ii) It is destroyed or disintegrated by specific enzymes.

iii) It is engulfed or removed by astrocytes.

iv) It is removed by means of reuptake (macrophages) into the axon terminals.

Reflex Activity →

Reflex activity is the response to the peripheral nervous stimulation that occurs without.

It is a type of protective mechanism.

Reflex Arc → This is the anatomical pathway for the reflex action.

Receptors



Afferent Neuron



Centre



Efferent Neuron



Effector Organ

Classification of Reflex →

They are classified in 5 different methods -

1)

1)

The uncondition reflexes are the natural reflexes which are present since the time of birth.

Such reflexes do not require previous learning training or conditioning.

Eg: Secretⁿ of saliva when a drop of honey is

kept in the mouth of new born baby for the first time.

2) These are the reflexes that develop after conditioning or training.

- These reflexes need previous learning, training or condition.

Eg: Secretion of saliva by

2) Depending upon the situation

a) Cerebellar reflexes -

- These are reflexes which have centre in cerebellum.

b) Cortical reflexes -

- These have the centre in cerebral cortex.

c) Midbrain reflex -

- These reflexes have centre in midbrain.

d) Medullary

- These reflexes have the centre in medulla oblongata.

e) Spinal reflexes -

- Reflexes having their centre in spinal cord.

i)

ii) Intrasegmental

iii) Suprasegmental spinal reflexion

3) Depending upon the

1) Protective reflexes / flexor reflexes -

- These reflexes protect the body from harmful stimulation.

Protective reflexes involve flexion at the different joint. Hence, they are called as the flexor reflex or

- 2) Anti-gravity reflex /
- This reflexes protect the body against

The extensor muscle contracts during this reflexes resulting in extensor joint.

- 3) Depending Upon the no of

i) Monosynaptic Reflexes -

The reflexes having only one synapse in the reflex arc are called monosynaptic reflexes.

Eg:- Stretch receptors.

ii) Polysynaptic Reflexes -

The reflexes having more than one synapse in the reflex arc are called as polysynaptic reflexes.

Eg:- flexor reflexes.

- 5) Depending Upon

In clinical practice reflexes are classified into 4 types -

1) Superficial Reflexes.

2) Deep Reflexes

3) Visceral Reflexes

4) Pathological Reflexes

- 1) Superficial

S.R are reflexes which are elicited from the surface of the body.

They are of 2 types -

i) Mucous membrane reflex -

The mucous membrane reflexes are arising

from the mucous membrane

Reflex	Stimulus	Response	Afferent Nerve	Centre	Efferent Nerve
1) Corneal Reflex	irritation of cornea	blinking of eye	5 th cranial (trigeminal)	Pons	7 th cranial nerve (facial)
2) Conjunctival Reflex	irritation of conjunctiva	blinking of eye	5 th cranial	Pons	7 th cranial nerve
3) Nasal Reflex	irritation of nasal mucous mem	snizzing	5 th cranial	Motor nuclei of trigeminal nerve	10 th nerve & upper cervical nerve
4) Pharyngeal reflex	irritation of pharyngeal mucous membrane	gagging	9 th cranial	Nuclei of 10 th cranial nerve	10 th cranial (vagus)
5)		Rising of Uvula	9 th cranial (glossopharyngeal)	10 th cranial nerve	10 th cranial nerve

ii) Cutaneous reflexes —

Reflex	Stimulus	Response	Centre
1) Scapular Reflex	irritation of skin at the interscapular space	Contract ⁿ of scapular muscle & drawing in of scapula	C ₅ to T ₁
2) Upper abdominal Reflex	stroking the abdominal wall below the costal margin	Epsilateral contraction of abdominal muscle & movement of umbilicus towards the sight of stroke	T ₆ to T ₉
3) Lower abdominal Reflex	stroking the abdominal wall at the umbilical level & iliac level	Epsilateral contraction of abdominal muscle & movement	T ₁₀ to T ₁₂
4) Cremasteric Reflex	stroking the skin at the upper	Elimination of testicle	L ₁ & L ₂
5) Glutial Reflex	stroking the skin over	Contraction of glutie.	L ₄ to S ₁ , S ₂

6)	Plantar Reflex			L5 & S2
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7)	Bulbo-cava	stroking the dorsum of glans penis	Contraction of bulbocavernosus muscle	S3 & S4
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8)	Anal Reflex	stroking the perianal reflex		S4 & S5
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2) Deep Reflex —

The D.R are initiated from the deeper str. beneath the skin like tendons.

1)	Jaw jerk	Tapping middle	Closure of mouth	Pons with 5th cranial nerve
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2)	Biceps jerk	Percussion of biceps tendon	Flexion of forearm	C5, C6
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3)	Triceps jerk	Percussion of triceps tendon	Extension of forearm	C6 to C8
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4)	Supinator jerk	Percussion of tendon over distal end of radius	supination & flexion of forearm	C7, C8
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5)	Wrist tendon	Percussion of wrist tendon	flexion of corresponding fingers	C8 & T1
6)	Knee jerk or patellar tendon reflex	Percut ⁿ of patellar ligament	Extension of leg	L2 to L4
7)	Ankle jerk	Percussion of achilles tendons	Plantar flexion of foot	C5 to S2

3)

2) Pupillary Reflex -

P.R are the reflexes in which the size of pupils is alters.

P.R are again of 3 types -

- i) light reflex
- ii) Accommodation reflex
- iii) Ciliospinal reflex

i) Light Reflex -

In the retina is stimulated by sudden flash of light contraction of pupils occur. It is called as light reflex.

They are of 2 types -

i) Direct light reflex

ii) Indirect light reflex

i) D.L.R - Stimulatⁿ of retina in one eye by the flash of light causes the constrictⁿ of pupil phy in the same eye.

ii) I.L.R - Stimulatⁿ of retina in one eye cause^s the constrictⁿ of pupil in other eye also.

ii) Accommodatⁿ Reflex -

When the eyes are fixed on the distant object & if another object is brought in front of the eyes the vision shifts from far object to near object, the changes in the eyes are one constriction of pupils convergens of eye ball & see increase in anterior curvature of lens.

iii) Ciliospinal Reflex -

- Dilutⁿ of pupil due to stimulatⁿ of skin over the neck.

2)

- Heart rate ↓ due to pressure cupplied over eye ball.

3)

- Decreasing heart rate & blood pressure cause by pressure over kerotiesinus in neck due to tight colour.

4) Pathological Reflexes —
The reflexes that are initiated in the pathological condition.

i) In the normal plantar reflex a generator scratch over the outer edge of the sole causes plantar flexion & adduction of all toes.

This condition is called as
it is present in upper motor neuron

ii) When a deep reflex is initiated in a normal person the contraction of the muscles or the group of muscles

phy

* Properties of Reflex -

1) One way conduction - As per Low the impulses are transmitted in one direction through the reflex arc, the impulse pass from receptor to the afferent nerve fiber then to the centre then to the efferent nerve.

2) Reaction time - R.T is a time betⁿ interval betⁿ applicatⁿ of stimulus & the on. set of stimulus. It depends upon the length of afferent & efferent fibers, velocity of impulse & central delay.

3) Summation - They are of 2 types -

i) Spatial summation - When two nerve fibers supplying a muscles are stimulated separately with subliminal there is no response, but the muscles contract when both the nerve fibers are stimulated together with the same strength of stimulus.

ii) Temporal summation - When one nerve fiber is stimulated repeatedly with subliminal stimuli this stimuli come send the to give response to muscle, this is called as temporal summation.

4) Acculusion -

When both the nerves are stimulated simultaneously the tension developed by the muscle is less than the sum of the tension developed when each nerve is stimulated separately. This is acculusion.

5) Subliminal

The tension developed by simultaneous stimulation of two nerves is greater than sum of tension produced by the stimulation.

6)

It is defined as the activation of additional motor units with progressive increase in force of muscles contract.

7) After discharge - After discharge is persistence of continuation of response for some time even after removal of stimulus. It is because of discharge of impulses from the centre even after stoppage of stimulus.

8)

phenomena - When the inhibition is suddenly removed the reflex activity becomes more forceful than before inhibition. It is called as rebound phenomena.

9) Fatigue - When a reflex activity is

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continuously for long time the response is reduced slowly & at one stage the response does not occur. This type of failure to give response to the stimulus is called as fatigue.

* Reciprocal Inhibition —

The excitation of one group of muscles is associated with inhibition of another.
Eg: When the flexor reflex is initiated, the flexor muscle are excited & the extensor muscle are inhibited on that same sight this phenomenon is called as reciprocal inhibition.

*

The afferent nerve fibers which ~~know~~ ^{excite} flexor reflex in the limb have connectⁿ with motor neuron supplying flexors & the motor neuron supplying extensor on the same sight. The afferent nerve fibers excites the motor neuron supplying flexor, simultaneously it also inhibates the motor neuron supplying the extensor.

* Physiology of Pain

Pain is defined as unpleasant & emotional associated with or without actual tissue damage.

The pain sensatⁿ is described the sharp, pricking, cutting, shooting, sh.

0.

Pain may be acute or chronic.

Acute Pain - Acute pain is a sharp pain of short duratⁿ with easily identified cause. It is localised in small area.

* before spreading in

It can be easily treated by medicine.

Chronic Pain - Chronic pain is interm or constant pain with different intensities which lasts for longer duration of time.

It is difficult to treat.

• Components of Pain Sensatⁿ -

Pain stimulus produce 2 pain sensatⁿ -

- 1) Fast pain
- 2) Slow pain

1) Fast pain - Fast pain is first sensatⁿ whenever a pain stimulus is applied.

It is experienced as a bright, sharp & localised pain sensation.

The fast pain sensatⁿ is carried by [Aδ] nerve fibers.

2) Slow pain - The slow pain is experienced as a dull, diffused & unpleasant pain. Slow pain is carried by C type of nerve fibers.

* Pathways of Pain Sensation —

Pain sensation from various parts of the body is carried to brain by different pathways —

1) Pathway from skin & deeper str.

2) Pathway from face

3) Pathway from viscera

4) Pathway from pelvic region

1) from skin & deeper str. →

a) Receptors - These are free nerve endings which are distributed throughout body. 1st order neurons → 1st order neurons are cells in the posterior nerve root ganglion

Pain receptor

↓
Dendrites

↓
Cells

↓
Axon

↓
Spinal cord

Fast pain sensation is carried by Aδ type of afferent nerve fibers which synapse with neurons of marginal nucleus in

slow pain & sensation is carried by C type of afferent nerve fibers which synapse with neurons of substantia gelatinosa of Rolando in posterior grey cord of spinal cord.

● 2nd Order Neuron - The neurons of marginal nucleus & substantia genitosa of rolando form the 2nd order neuron. fibers of the fast pain arises from the marginal nucleus & the fibers of the slow pain arise from the neurons of substantia genitosa.

Where
nucleus of
the nucleus
present

3rd Order Neuron -

3rd order neurons of pain path-
way are neurons in thalamic nucleus.

b) Reticular formation

d) grey matter around the aqueduct sylvius.

• Centre for Pain Sensation -

Is in the post central gyrus of parietal cortex.

2) Pathway of the pain sensation from the face is carried by

3) Pathway of pain sensation from viscera -
Pain sensation from thoracic & viscera is transmitted by sympathetic nerve that is

Pain from oesophagus, trachea & vagus is carried by glossopharyngeal nerve.

4) Pathway of pain sensation from pelvic region
Is carried by sacral parasympathetic nerve.

* Referred Pain →

Referred pain is the pain that is perceived at the site adjacent to away from the site of origin.

ex. 1) Cardiac pain is felt at the inner part of the left arm & left shoulder.

2) Pain in ovary is referred to umbilicus.

3) Pain from testis is felt in abdomen.

4) Pain in diaphragm is referred to right shoulder.

5) Pain in gall bladder is referred to epigastric region.

6) Renal pain is referred to _____.

* 7) Neurotransmitter involved in pain

↳ Glutamate & _____ are substance

Aδ afferent nerve fibers which transmits the impulse of fast pain secretes glutamate.

C type nerve fibers which transmits impulse of slow pain secretes substance-P.